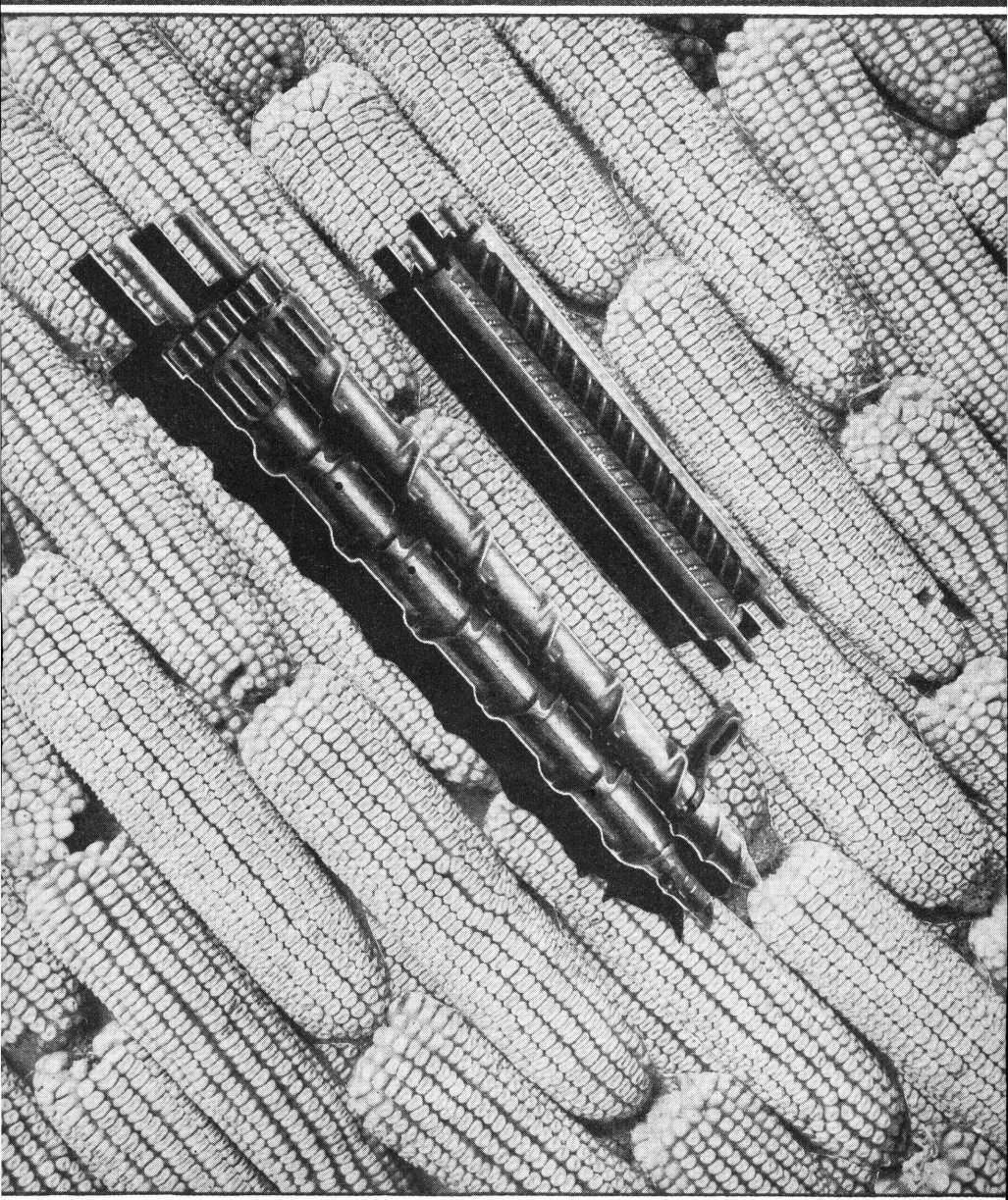
MECHANIZING THE CORN HARVEST



FARMERS' BULLETIN No. 1816
U.S. DEPARTMENT OF AGRICULTURE

CORN-PICKER PERFORMANCE

An ordinary corn crop harvested as grain in the United States is about 2 billion bushels or 70 million tons of ear corn. If harvested by hand, the total harvesting labor is estimated as 250 million man-hours.

Single-row horse-drawn machine corn pickers were sold in limited numbers as early as 1904. Two-row tractor pickers first came on the market in 1928. The number of these machines in use on large corn farms has increased rapidly, but probably more than 90 percent of the United States' crop is still harvested by hand.

Time studies of corn harvesting by machine show that the total labor of harvesting with the best machinery now available is about one-fourth of the labor required for hand husking.

Under unfavorable conditions machine corn pickers leave more corn in the field than do hand pickers.

In the central part of the corn belt field losses with machines increase after the first of November, when the cornstalks deteriorate as a result of weathering. Machine picking should be finished early in November.

Corn-picker performance can be materially improved by growing a corn hybrid which is well adapted to machine harvesting.

Machine harvesting has a special advantage on farms where general-purpose tractors are already in use for tillage operations.

Corn pickers can be and are operated safely by a large proportion of the farmers who use them.

THE COVER DESIGN

The front cover shows the two most characteristic parts of the mechanical corn picker—the snapping rolls (lower), which break the ears from the stalks, and the husking rolls, which tear the husks from the ears. The picture shows the rolls much reduced in size in comparison with the ears of corn.

Washington, D. C. Issued December 1938

MECHANIZING THE CORN HARVEST [1]

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INTRODUCTION

HARVESTING THE CORN CROP requires more labor than harvesting all the other grain crops. The weight of corn to be handled is greater, and the work is done largely by hand, whereas small grain is harvested by machine.

According to the Statistics of Agriculture, 1937, the 1935 crop of corn harvested as grain in the United States was 2,015,007,000 bushels; the total production of all other grains was 2,281,887,000 bushels. In round numbers the ordinary corn crop harvested as grain is about 2 billion bushels, which as ear corn at 70 pounds per bushel weighs 70 million tons. The total of all other grain crops is about 2¼ billion bushels, or 50 million tons of threshed grain.

The purpose of this bulletin is to aid the farmer in deciding what corn-harvesting methods and equipment are best in his circumstances.

HARVESTING METHODS

There are two methods of harvesting corn as grain. One method consists of cutting and shocking the corn before frost and husking out the ears after the fodder has cured. This method is followed where the acreage of corn per farm is small and in portions of the Corn Belt where winter wheat follows corn. Because of the large amount of labor involved it is impractical where a large acreage of corn is grown for grain. The other method is to allow the corn to stand until the ears are dry enough for storing when the ears are husked from the standing stalks. This is the usual procedure in regions where corn is grown in large quantities primarily for grain and where a spring-seeded crop follows the corn.

Recently in parts of the Corn Belt there has been considerable interest in combining, or field-shelling, corn. However, as combining has been employed only to a limited extent, it is not discussed in this bulletin.

[1] Projects 394 and 476 of the Iowa Agricultural Experiment Station.

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LABOR OF HAND HUSKING

The labor used for husking corn from standing stalks by hand varies widely with the yield of corn and the strength and skill of the huskers. The custom of paying wages by the bushel has no doubt had an influence in developing skill. A spirit of athletic competition has also played its part in the development of speed. The best performers in recent husking contests have husked approximately 40 bushels in the standard 80-minute period, that is, 30 bushels per hour.

In Iowa a labor record was obtained on a typical farm where husking was done by hand. With a yield of 70 bushels per acre the total harvesting labor per acre was 9 man-hours, 7.5 hours of which was spent in the field and the other 1.5 hours in taking care of horses and unloading the corn from wagons into cribs by hand scooping. This was at the rate of 7.8 bushels per hour of total labor.

In central Illinois labor records were obtained of the hand husking of 392 fields comprising a total of 11,835 acres during 1920 to 1928 and were reported on in Illinois Station Bulletin 373, Harvesting the Corn Crop in Illinois. The average labor requirement per acre was found to vary with yield as follows: 30 bushels, 4.00 man-hours; 40 bushels, 4.60 man-hours; 50 bushels, 5.38 man-hours; 60 bushels, 5.72 man-hours; and 70 bushels, 6.23 man-hours. The average rate of work in bushels per man-hour ranged from 7.92 with low yields to 10.82 with high yields.

In central Indiana according to Indiana Station Bulletin 362, Mechanical Corn Pickers in Indiana, the average labor requirement for hand husking was 5.35 man-hours per acre with yields of 40 to 50 bushels per acre.

The average yield of corn in the United States is between 25 and 30 bushels per acre. If 8 bushels per man-hour is assumed to be the rate of harvesting by hand, the labor involved in hand harvesting a 2-billion-bushel crop is 250 million man-hours.

DEVELOPMENT OF MECHANICAL EQUIPMENT FOR CORN HARVESTING

Mechanization of harvesting corn by husking the ears from standing stalks in the field started at a much later date than the mechanization of small-grain harvesting. A few machine corn pickers were sold to farmers as early as 1904. The early machines had essentially the same mechanical elements as are now used for snapping and husking the ears, but they were not entirely successful as they were single-row, ground-driven and horse-drawn and were not as well built as later machines. Often little if any more corn was harvested per man than could be husked by hand.

From 1928 to 1933 several large manufacturers began to produce two-row corn pickers, either tractor-drawn or mounted on a general-purpose tractor. The picker mechanisms of these machines were driven by power take-off from the tractor, which also towed a wagon to receive the corn. These arrangements made them one-man outfits. In comparison with the earlier pickers, the machines were improved to accomplish better pick-up of broken or leaning stalks and to reduce

clogging. They had structural improvements such as enclosed gears running in oil, steel-roller chain drives, improved bearings with fittings for grease-gun lubrication, and slip clutches to prevent breakage of machine parts in case of clogging. These machines have been successful in field operation and have reduced materially the labor required for harvesting corn in comparison with hand husking. Single-row machines of similar design are also available and may be preferable on the smaller farms. While the number of machine corn pickers in use on farms has increased quite rapidly in recent years, the area harvested by them is probably less than 10 percent of the total acreage of corn harvested for grain.

The job of unloading ear corn from the wagons into cribs on the farm has been mechanized to a greater extent than the husking. Stationary or portable ear-corn elevators are in use on most of the larger farms in the Corn Belt. The elimination of hand scooping is no small saving since many family-size farms produce more than 350 tons of ear corn.

LABOR OF HARVESTING WITH MACHINE PICKERS

Time studies of machine harvesting were started in 1931 and continued through 1937 at Ames, Iowa. Detailed data from 1931, 1932, and 1933 tests were published in Iowa Station Bulletin 365, Labor, Power, and Machinery in Corn Production. The equipment used at that time traveled on steel wheels; that used in 1936 and 1937 was mounted on rubber-tired wheels. Prior to 1937 the corn was stored in small cribs. A portable elevator was used to unload wagons. In 1937 an 8,000-bushel crib with an inside elevator and pit was constructed on the experiment farm near Ames, and this was used when the 1937 time studies were made.

In the tests at Ames whenever conditions were favorable it was found possible to operate pickers at a speed of 3 miles per hour without apparent adverse effect upon machine performance as compared with operation at slower speeds.

If operation were continuous at the 3-mile speed, a two-row machine would harvest 2½ acres per hour, but this is always reduced by time required for turning, for changing wagons, and for other incidental delays.

In the earlier time studies, when the portable elevator was used for unloading wagons, it took two men to haul and unload the corn from a two-row picker in corn yielding 60 to 70 bushels per acre. The two men had some idle time, however. In the 1937 studies, when the inside elevator and dump pit were used, one man was able to haul, weigh, and crib the corn from a two-row picker with yields up to 80 bushels per acre (table 1). The labor required for hauling and cribbing depends upon yield, size of loads, convenience of wagon hitches, length of haul, and speed of travel as well as upon equipment used for unloading. With all of these factors to consider, it it often difficult to plan the crew and equipment so as to avoid having some idle labor.

TABLE 1.—*Time required for corn-picker operations, 1937*

Crew		2 men	1 man.
Length of test		1 hour 27 minutes	1 hour 39½ minutes.
Power for towing wagons		Pick-up truck	Tractor on which picker was mounted.
Distance from field to storage building	mile	0.4	0.4.
Length of field rows	rods	40	80.
Average yield per acre	bushels	79.3	59.8.
Average time to pick 1 load, including stops, turns and coupling	minutes	14½	
Time to pick 3 loads, including stops, turns, and coupling	minutes		65½.
Average load	bushels	34.9	40.3.
Average time to haul, weigh, dump, and elevate 1 load	minutes	13	
Time to haul, weigh, dump, and elevate 3 loads	do		34.
Area husked and cribbed per hour	acres	1.8	1.2.
Corn husked and cribbed per hour	bushels	143	72.7.
Time required per acre	man-hours	1.1	0.83.
Corn husked and cribbed per man-hour	bushels	71.5	72.7.

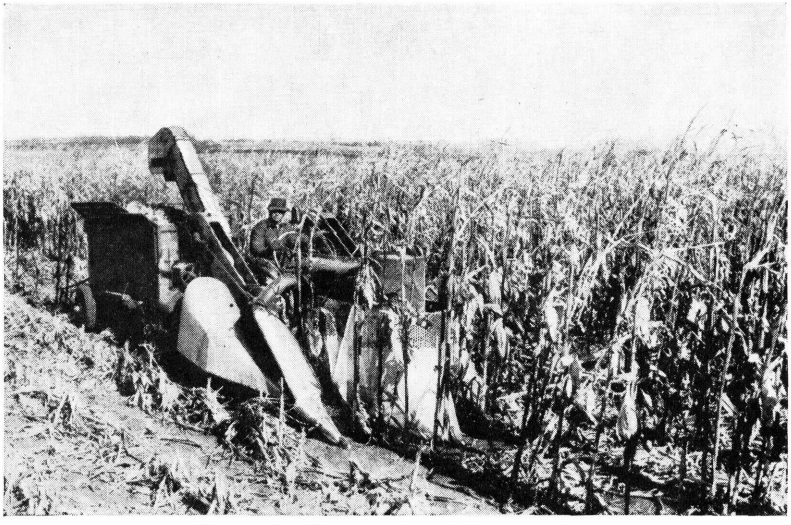

FIGURE 1.—Two-row mounted corn picker.

Two time records of corn harvesting taken in 1937 are given in table 1. The first of these records was taken with a crew of two men: one operating the picker (fig. 1) and the other hauling and cribbing the corn (fig. 2). The second record was taken with one man doing the entire job alone by going to the field with a train of three empty wagons coupled behind the tractor on which the picker was mounted; picking three loads of corn; and again coupling the three wagons behind the tractor-picker for hauling them to the storage building (fig. 3). The picker used in making both of these records was a two-row machine mounted on a rubber-tired, general-purpose tractor. The wagons had rubber tires, were equipped with telescoping tongues, and had capacity of 40 bushels of ear corn each. When operating with a two-man crew, a pick-up truck was used for towing wagons. At the storage building, the corn was weighed and then unloaded by the inside elevator with dump pit.

The work was done by experienced workmen. They were instructed to avoid any unnecessary loss of time but not to work at more than

normal speed. Soil, weather, and crop conditions were favorable for machine harvesting.

The time records given in table 1 do not include the time required for servicing the equipment, which was 1 to 1½ man hours a day and would add about 10 percent to the labor requirements shown in the table.

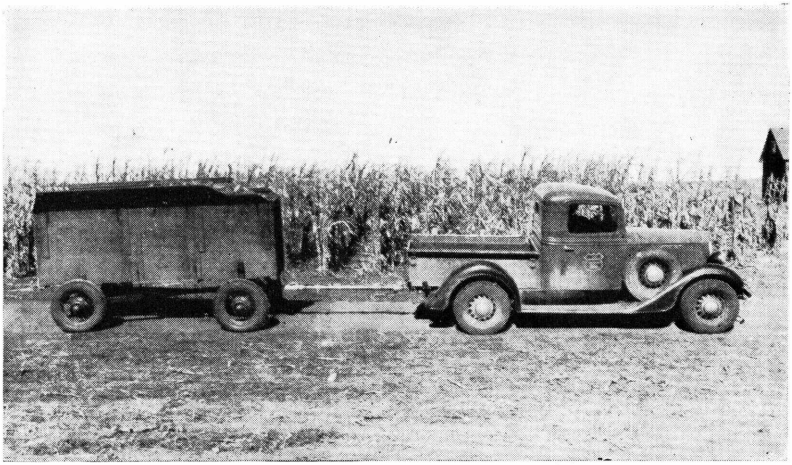

FIGURE 2.—Loaded wagon being towed to storage by light truck.

In estimating the total labor required for the harvest, allowance must be made for taking the picker out of storage at the beginning of the season and putting it back at the end. With a mounted picker this may require 3 or 4 man-days. If a pull-type picker is used, allow-

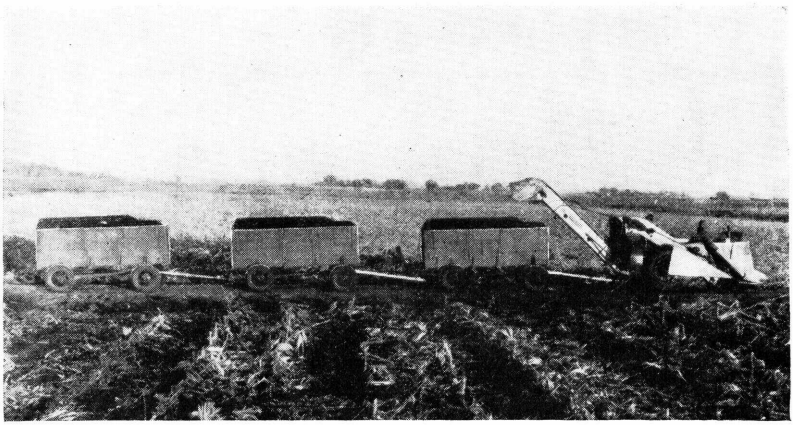

FIGURE 3.—One-man outfit for harvesting and cribbing corn, using two-row mounted picker and three wagons.

ance should be made for the labor of hand husking headlands and field openings. When due allowance is made for all miscellaneous harvesting labor and for unfavorable weather, the total labor requirement for harvesting yields of 60 to 70 bushels per acre is likely to be 1½ to 2 man-hours per acre with the best equipment now avail-

able. This is roughly about one-fourth of the labor required for hand husking.

KIND OF CORN ADAPTED TO MACHINE HARVESTING

To the extent that they can be developed without sacrificing yield, the corn-plant characteristics desirable for machine picking are: Stiff stalks to resist storm damage, tough ear shanks to reduce the number of ears that drop off before harvest, large ears, and hard shelling to reduce shelled-corn loss at the snapping rollers. Tough ear shanks tend to increase shelled-corn loss, which limits the advantage to be gained from this characteristic.

To test the adaptability of different kinds of corn to machine harvesting, one open-pollinated variety and three hybrids were planted together, four rows of each, in replicated plots in 1937. Harvesting tests were made on three dates, the results of which are recorded in table 2. The corn designated as A was the Krug variety; B, C, and D were Iowa Agricultural Experiment Station hybrids Nos. 942, 13, and 939 respectively. In the comparison of the quantity of corn left in the field in terms of percentage of total yield, it is observed that hybrid D excelled in each series of tests, the field losses with this hybrid being less than half of those with Krug.

TABLE 2.—*Field losses of four varieties of corn harvested by mechanical pickers in 1937*

Date of test	Kind of corn	Ears on standing stalks	Ears on down stalks	Ears loose on ground	Moisture in shelled corn	Condition of ground	Gleanings per acre							Harvested per acre by picker	Total yield
							Loose ears before picking	Ears after picking	Shelled corn after picking	Gleanings after picking		Total gleanings			
											Percent of yield		*Percent of yield*		
1937		*Percent*	*Percent*	*Percent*	*Percent*		*Bushels*	*Bushels*	*Bushels*	*Bushels*		*Bushels*		*Bushels*	*Bushels*
Oct. 28	A	93.3	5.4	1.3	19.2	Dry	1.05	2.25	0.88	3.13	3.62	4.18	4.83	82.3	86.5
Do	B	97.6	.8	1.6	16.6	do	1.16	.55	2.08	2.63	2.60	3.79	3.74	97.5	101.3
Do	C	100.0	0	0	17.6	do	0	.04	2.53	2.57	2.65	2.57	2.66	94.2	96.8
Do	D	99.0	1.0	0	17.5	do	0	.53	1.18	1.71	1.96	1.71	1.96	85.5	87.2
Nov. 6	A	88.1	6.8	5.1	15.7	do	3.78	5.15	3.74	8.89	9.51	12.67	13.55	80.7	93.4
Do	B	94.3	2.2	3.5	14.0	do	2.24	.82	2.46	3.28	3.60	5.52	6.06	85.6	91.1
Do	C	96.6	1.5	1.9	14.6	do	1.08	3.80	3.90	7.70	7.38	8.78	8.41	95.4	104.2
Do	D	98.5	.5	1.0	15.6	do	.84	.68	1.72	2.40	2.92	3.24	3.94	79.0	82.2
Nov. 26	A	68.6	15.7	15.7	14.3	Frozen	15.3	4.5	3.3	7.8	8.21	23.1	24.35	71.9	95.0
Do	B	91.1	4.0	4.9	13.7	do	4.49	.89	12.20	13.09	13.54	17.58	18.20	79.0	96.6
Do	C	81.1	10.2	8.7	15.0	do	8.87	2.39	5.57	7.96	7.70	16.83	16.30	86.6	103.4
Do	D	87.3	5.3	7.4	14.3	do	4.84	.55	2.93	3.56	4.55	8.30	10.60	69.9	78.2

In the comparison of the yield of corn placed in the wagon by the picker the B and C hybrids were better than D even though somewhat more corn was left in the field.

There may be opportunity for plant breeders to further improve corn from the standpoint of adaptability to machine harvesting.

FIELD LOSSES

Hand huskers leave some corn in the field, but the amount was not measured in the Iowa investigations. In the central Indiana experiments a check was made of corn left by hand huskers in 25 fields in 1930 and in 1931. The smallest quantity left was 0.77 percent and the largest 7.13 percent of the yield. The average left by owners was 2.05 percent; by hired help, 4.39 percent; and by all, 2.75 percent of the yield.

Table 2 shows the corn left in the field by mechanical pickers in the tests at Ames. These losses are also shown graphically in figure 4. The loss of each kind of corn on October 28 was below 5 percent, and the loss of hybrid D was below 2 percent. Losses increased rapidly in November, especially those of variety A — Krug. The corn was very dry at the end of November. Losses with hybrid B on November 26 were large on account of easy shelling and consequent excessive loss of shelled corn.

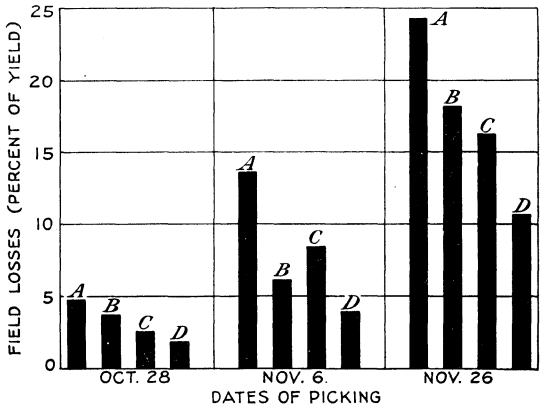

FIGURE 4.—Losses of corn from four varieties on three picking dates.

The field losses in the October tests recorded in table 2 were materially lower than those shown in previously published results for the years 1931, 1932, and 1933. This improvement is thought to be due largely to the better condition of the crop in the early part of the 1937 harvesting season.

HOW TO IMPROVE CORN-PICKER PERFORMANCE

Two important things a farmer can do to keep down field losses in corn-picker operations are: (1) Choose a kind of hybrid corn that is adapted to machine harvesting and (2) plan operations so that harvesting will be finished early in November.

It is assumed that the importance of careful operation and proper adjustment of the machine are recognized. Adjustment of snapping rollers should receive special attention as too wide an opening may cause excessive loss of shelled corn.

Investigations at Ames have shown that corn pickers do their best work early in the season before the crop has become dry and brittle and before it has been damaged by late-fall storms. The progressive

increase in field losses shown in table 2 and figure 4 is the result of November being dry and free from severe storms. Previously published data also show increased losses, as the season progressed.

COORDINATION OF GROWING AND HARVESTING EQUIPMENT

On a farm where corn is cultivated with single-row, horse-drawn cultivators, the logical method of harvesting seems to be hand husking. The acreage grown per man is limited to approximately 40 acres. It is possible for a good hand husker to harvest this acreage without additional help.

If larger teams and two-row cultivators are used, one man may grow about 80 acres. It will then be necessary to hire additional help for harvesting. There will be enough horses on the farm to pull wagons for hand husking, so there is no power problem involved; the only problem is to obtain the necessary extra help.

In case a general-purpose tractor is used for growing the crop, it is not unusual to produce 100 to 150 acres of corn per man and, under some conditions, even larger acreages are handled. Thus the acreage grown per man is sometimes three or four times as much as one man can harvest by hand. Furthermore, on farms where fewer horses are now used for tillage operations, there are not enough on the farm to pull the wagons needed for hand husking. In such cases harvesting by hand becomes a power problem as well as a labor problem, since the farmer must hire both extra men and extra teams. Using a mechanical picker seems to be the logical way to coordinate the labor and power requirements for harvesting and growing the crop where a general-purpose tractor is used for tillage operations.

A TELESCOPING WAGON TONGUE

A telescoping wagon tongue that will save time and labor and practically eliminate the danger of bodily injury in tractor coupling has been employed by the authors of this bulletin in harvesting corn. Time records of the operation of a mounted picker with regular wagon-hitch equipment showed that it took two men to change wagons and the time consumed in changing wagons was 12.7 percent of the operating time. With telescoping tongues (figs. 5 and 6) one man changed wagons without assistance and the time was reduced to 4.5 percent of the operating time. The telescoping tongue can be used with a tractor or with horses.

The tongue is made of two sizes of square steel pipe, the smaller pipe forming the forward part of the tongue and telescoping into the larger pipe, and is equipped with an automatic catch to lock it in the short position. In the extended position, the tongue is the right length for a horse hitch. It may be locked in the extended position by use of a pin through the tongue.

To couple a wagon to a tractor, the operator stops the tractor in position so that its drawbar is within about 4 feet of the end of the wagon tongue; he then gets off, unlatches the tongue, pulls it out to the right length to reach the tractor drawbar, and makes the coupling. Having the tongue coupled in partially extended position, he gets back on the tractor and backs up until the tongue locks in its short position. If the coupling is made with the tongue in a cramped posi-

tion, it may be necessary to drive ahead and get the wagon straightened out behind the tractor before backing up to latch the tongue. In a similar manner one man can easily couple two or more wagons

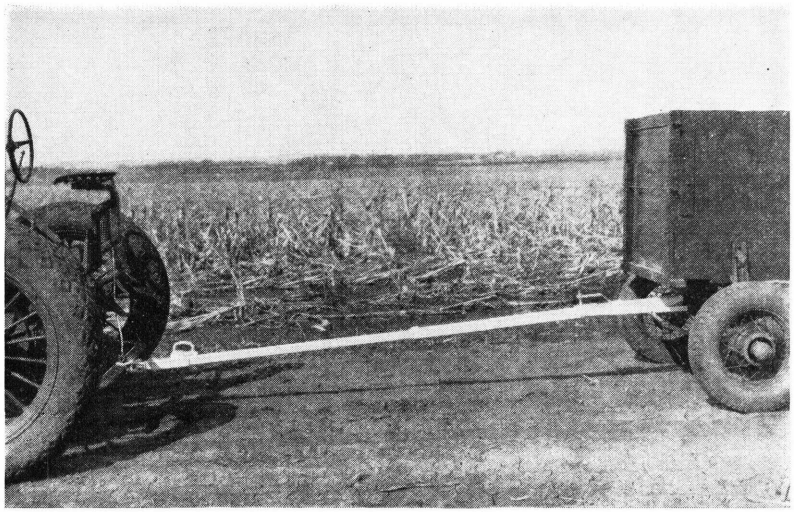

FIGURE 5.—Telescoping wagon tongue in extended position.

in a train when the wagons are equipped with telescoping tongues and with rear drawbar. The practice followed by the authors when harvesting corn with a one-man crew and mounted picker was to

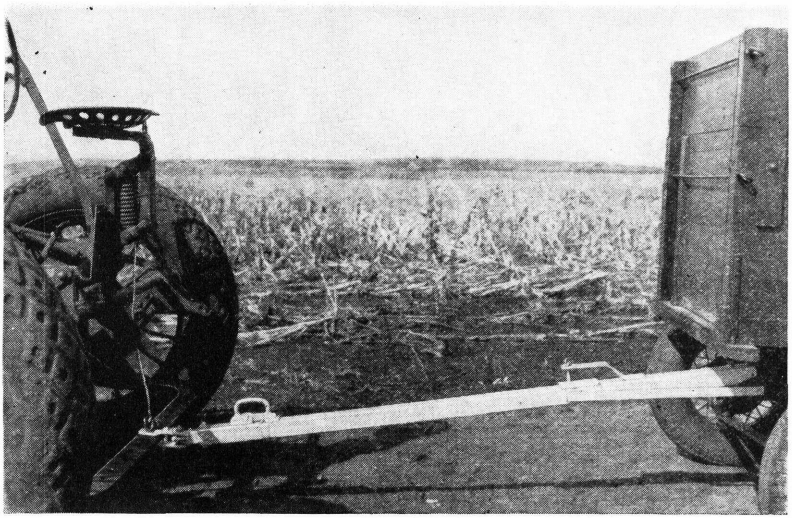

FIGURE 6.—Telescoping wagon tongue in shortened position.

couple three empty wagons in a train behind the tractor when going to the field. Upon reaching the field, the operator dropped off the third wagon at the end of the field and pulled two wagons, picking into the front one until it was filled. He then coupled the rear

empty wagon to the tractor and the loaded wagon behind and picked out to the end of the field, where he dropped the loaded wagon and picked up the third empty. When the three wagons were full, he coupled them in a train behind the tractor. The change of wagons was made at whatever point in the field a wagon became full.

By using the new tongue in harvesting corn with a mechanical picker, one man can pick, haul, and crib the crop.

Plans for making the telescoping tongue in a well-equipped shop may be obtained from the Bureau of Agricultural Engineering upon request.

ACCIDENTS

The number of accidents with corn pickers in which men have suffered bodily injury is a matter of concern. Most operators of these machines can and do operate them safely because they take precautions against the several kinds of accidents liable to result through carelessness or failure to recognize the danger points. Safe operation of these machines requires more than usual care.

The following safety suggestions are offered:

1. Before buying a corn picker examine it carefully to see that guards are provided at all points where needed to prevent the operator's clothing from getting caught on shafting, gears, or other moving parts.

2. As the power take-off shaft is a potential danger point, especially on pull-type pickers, it should be provided with good guards to prevent contact with clothing and to prevent the shaft from swinging and striking the operator in case the slip joint should become disconnected while the shaft is in motion. The operator should see that these guards are in place before the picker is started even if it is to be used for only a short run.

The clutch which drives the power take-off should always be disengaged before turning around with a pull-type picker, and with any type of picker it should be disengaged before the operator leaves the tractor seat. It is almost never necessary to leave the seat with the power take-off shaft in motion, but if it is necessary, the operator should use special care to keep himself and his clothing clear of all moving parts.

3. The snapping rollers are built to take in cornstalks, and they cannot be mechanically guarded to prevent accidents in case mittens or hands are carelessly allowed to come in contact with them. The operator must always stay at a safe distance while they are in motion. Efforts to clear clogged rollers should not be made until the power is off. It may be easier to clear them when in motion, but it is too dangerous.

4. The operator's clothing must be free from parts that may easily get caught in gearing or chains or wrap around shafting. This applies to operators of all kinds of power machinery. Overcoat tails, unbuttoned coats, dangling shoestrings, sleeves unbuttoned at the wrist, and gauntlet gloves are all hazards that have led to accidents. A safety precaution is to wear bib overalls or overall suits that cover all other clothing. Boots outside of pant legs are good from the safety standpoint except that laces of lace boots are a hazard if they come untied or if loose ends are not covered.

5. A man's physical condition has much to do with his alertness and therefore an operator of power equipment needs to take good care of himself. This is a recognized requirement for safe driving of automobiles and trucks. It is dangerous to operate corn pickers and other power equipment when tired, sleepy, or sick.

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